

Collaborative Study for Analysis of high Resolution  
Infrared Atmospheric Spectra Between NASA Langley  
Research Center and the University of Denver

NASA Langley Research Center

Contract NCC-1-365

Final Report  
Summary of Research

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Feb. 18, 2002

## Summary of Research

The Langley-D.U. collaboration on the analysis of high resolution infrared atmospheric spectra covered a number of important studies of trace gases identification and quantification from field spectra, and spectral line parameters analysis.

The collaborative work included:

- \* Quantification and monitoring of trace gases from ground-based spectra available from various locations and seasons and from balloon flights.
- \* Identification and preliminary quantification of several isotopic species, including Oxygen and Sulfur isotopes.
- \* Search for new species on the available spectra, including the use of selective coadding of ground-based spectra for high signal to noise.
- \* Update of spectroscopic line parameters, by combining laboratory and atmospheric spectra with theoretical spectroscopy methods.
- \* Study of trends and correlations of atmosphere trace constituents.
- \* Algorithms developments, retrievals intercomparisons and automatization of the analysis of NDSC spectra, for both column amounts and vertical profiles.

Listed in the following are joint publications completed under this project.

1. C.P. Rinsland, R.J. Salawitch, G.L. Manney, M.R. Gunson, H.A. Michelsen, S. Solomon, R. Zander, E. Mahieu, A. Goldman, M.J. Newchurch, and F.W. Irion, "Polar Stratospheric Descent of  $\text{NO}_y$  and CO and Arctic Denitrification during Winter 1992-1993," JGR, 104, 1847-1861, 1999.
2. A. Perrin, J.-M. Flaud, F. Keller, A. Goldman, R.D. Blatherwick, F.J. Murcray, and C.P. Rinsland, "New Analysis of the  $v_8+v_9$  Band of  $\text{HNO}_3$  Line Positions and Intensities, and Resonances Involving the  $v_6=v_7=1$  Dark State," J. Molec. Spectrosc., 194, 113-123, 1999.
3. C.P. Rinsland, A. Goldman, F.J. Murcray, T.M. Stephen,

- N.S. Pougatchev, J. Fishman, S.J. David, R.D. Blatherwick, P.C. Novelli, N.B. Jones, and B.J. Connor, "Infrared Solar Spectroscopic Measurements of Free Tropospheric CO, C<sub>2</sub>H<sub>6</sub>, and HCN above Mauna Loa, Hawaii: Seasonal Variations and Evidence for Enhanced Emissions from the Southeast Asian Tropical Fires of 1997-1998," JGR, 104, 18,667-18,680, 1999.
4. A. Perrin, C.P. Rinsland, and A. Goldman, "Spectral Parameters for the  $\nu_6$  Region of HCOOH and its Measurement in the Tropospheric Spectrum," JGR, 104, 18,661-18,666, 1999.
  5. A. Goldman, R.R. Gamache, A. Perrin, J.-M. Flaud, C.P. Rinsland, and L.S. Rothman, "HITRAN Partition Functions and Weighted Transition-Moments Squared," JQSRT, 66, 455-486, 2000.
  6. A. Goldman, M.T. Coffey, T.M. Stephen, C.P. Rinsland, W.G. Mankin, and J.W. Hannigan, "Isotopic OCS in the Troposphere and Lower Stratosphere Determined from High Resolution Infrared Solar Absorption Spectra," JQSRT, 67, 447-455, 2000.
  7. C.P. Rinsland, A. Goldman, B.J. Connor, T.M. Stephen, N.B. Jones, S.W. Wood, F.J. Murcray, S.J. David, R.S. Blatherwick, N.S. Pougatchev, R. Zander, E. Mahieu, and P. Demoulin, "Correlation Relationships of Stratospheric Molecular Columns from High Spectral Resolution, Ground-Based Infrared Solar Absorption Spectra," JGR, 105, 14,637-14,652, 2000.
  8. T.M. Stephen, A. Goldman, A. Perrin, J.-M. Flaud, F. Keller, and C.P. Rinsland, "New high resolution analysis of the  $3\nu_3$  and  $2\nu_1+\nu_3$  bands of nitrogen dioxide (NO<sub>2</sub>) by Fourier transform spectroscopy," J. Molec. Spectrosc., 201, 134-142, 2000.
  9. J.R. Gillis, A. Goldman, G. Stark, and C.P. Rinsland, "Line parameters for the  $A^2\Sigma - X^2\Pi$  bands of OH," JQSRT, 68, 225-230, 2001.
  10. C.P. Rinsland, A. Goldman, R. Zander, and E. Mahieu, "Enhanced Tropospheric HCN Columns above Kitt Peak during the 1982-1983 and 1997-1998 El Niño Warm Phases," JQSRT, 69, 3-8, 2001.
  11. A. Perrin, J.-M. Flaud, F. Keller, M.A.H. Smith, C.P. Rinsland, V. Malathy Devi, D. Chris Benner, T.M. Stephen, and A. Goldman, "The  $\nu_1 + \nu_3$  Bands of the <sup>16</sup>O<sup>17</sup>O<sup>16</sup>O and <sup>16</sup>O<sup>16</sup>O<sup>17</sup>O Isotopomer of Ozone," J. Molec. Spectrosc., in press, 2001.

12. C.P. Rinsland, E. Mahieu, R. Zander, N.B. Jones, A. Goldman, L.S. Chiou, T.M. Stephen, J.M. Russell III, J. Anderson, P. Demoulin, R. Sussmann, J. Notholt, S.W. Wood, A. Meier, D.W.T. Griffith, G.C. Toon, J.-F. Blavier, B. Sen, and F.J. Murcray, "Evidence for a Decline in Stratospheric Total Inorganic Chloride from Long-Term Ground-Based Infrared Solar Spectrometric Column Abundance Measurements," to be submitted to JGR, 2002.
13. A. Goldman, C.P. Rinsland, A. Perrin, J.-M. Flaud, A. Barbe, C. Camy-Peyret, M.T. Coffey, W.G. Mankin, J.W. Hannigan, T.M. Stephen, V. Malathy Devi, M.A.H. Smith, "Weak Ozone Isotopic Absorption in the 5  $\mu\text{m}$  Region from High Resolution FTIR Solar Spectra," JQSRT, in press, 2001.
14. A. Meier, A. Goldman, P.S. Manning, T.M. Stephen, C.P. Rinsland, N.B. Jones, and S. Wood, "Improvements to Air Mass Calculations for Ground-Based Infrared Measurements," JQSRT, in press, 2002.
15. C.P. Rinsland, N.B. Jones, B.J. Connor, S.W. Wood, A. Goldman, T.M. Stephen, F.J. Murcray, L.S. Chiou, R. Zander, and E. Mahieu, "Multiyear Infrared Solar Spectroscopic Measurements of HCN, CO, C<sub>2</sub>H<sub>6</sub>, and C<sub>2</sub>H<sub>2</sub> Tropospheric Columns above Lauder, New Zealand (45°S Latitude)," JGR, in press, 2002.
16. C.P. Rinsland, E. Mahieu, R. Zander, L.S. Chiou, A. Goldman, and N.B. Jones, "HF Stratospheric Columns above Kitt Peak (31.9°N Latitude): Trends from 1977 to 2001 and Correlations with HCl Stratospheric Columns," JQSRT, in press, 2002.